Atmospheric Physics II

4c. Given a Surface/1000-500 mb thickness chart, analyze the chart correctly as determined by a master solution.

Thickness

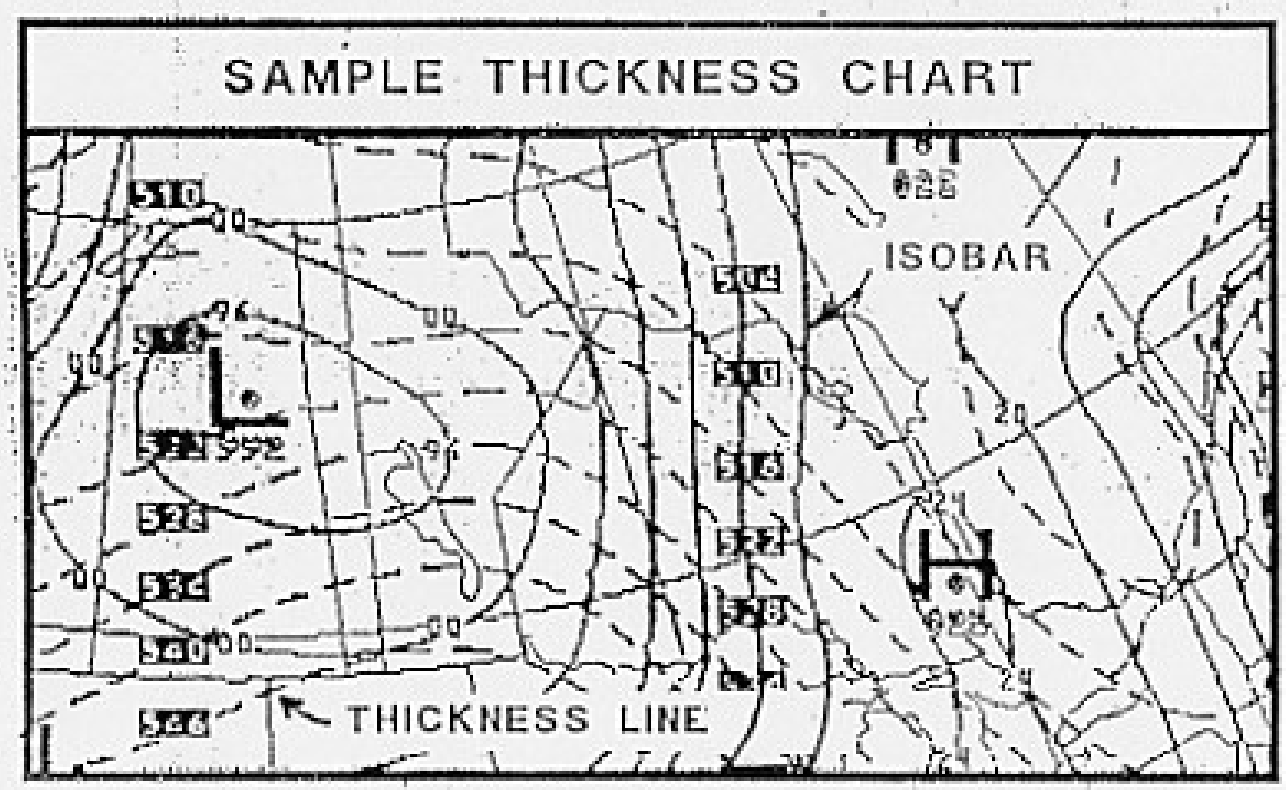
- Thickness is the vertical distance between two constant pressure surfaces.
- The thickness of a column of air is proportional to the mean virtual temperature of the layer.
  - The warmer the column, the higher its thickness.
  - The colder the column, the lower its thickness.
- Although moisture content will affect the thickness of a column, we normally associate thickness with temperature.

Thickness

- Moisture has a much smaller impact on thickness than temperature.
- While thickness can be computed using any two constant pressure surfaces, we will work with the 1000-500-mb thickness chart in this objective.

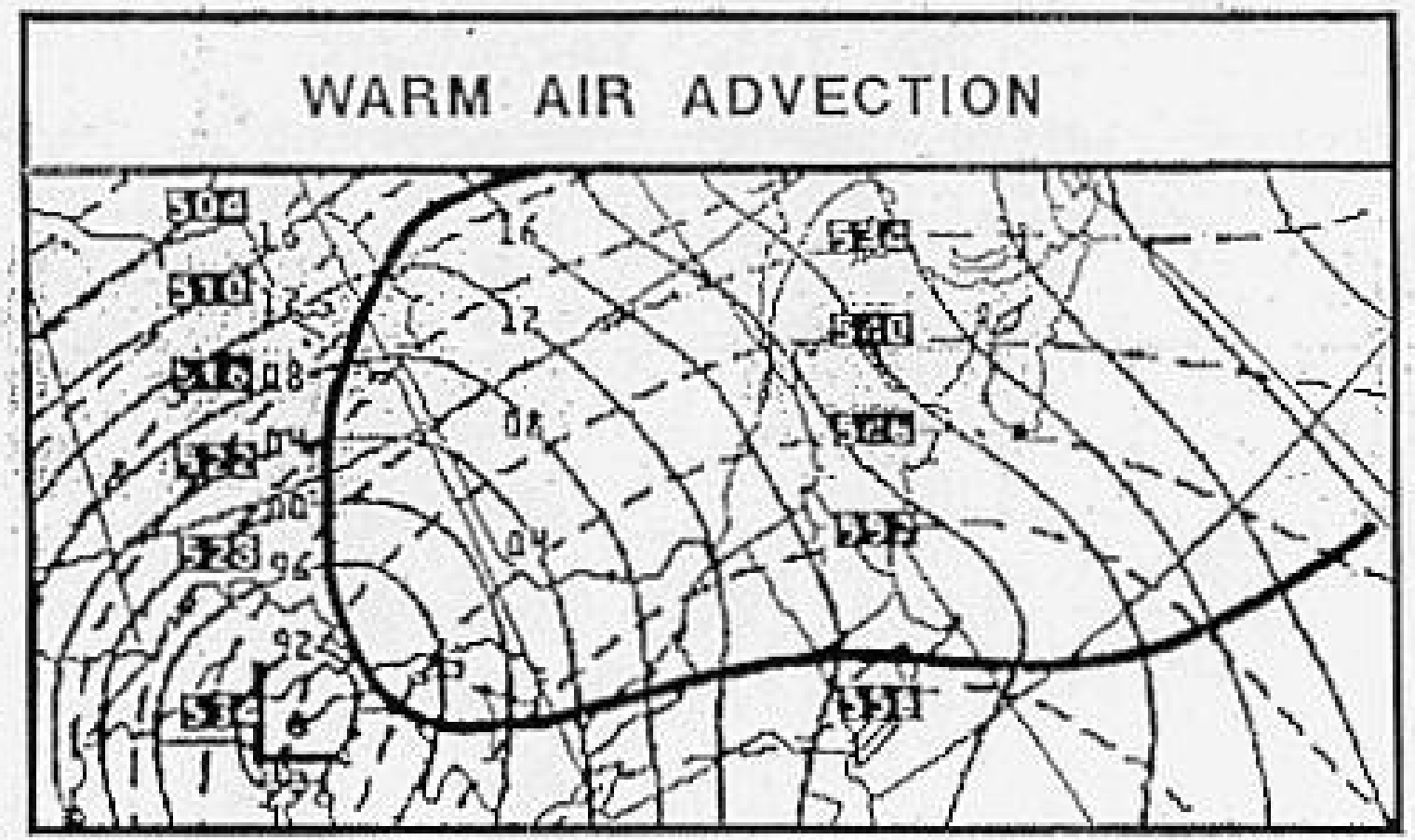
The SFC/1000-500 mb Thickness chart

- The solid lines are isobars of mean sea level (MSL) pressure, and are drawn every 4 mb from a base isobar of 1000 mb.
- The dashed lines are isopleths of 1000-500 mb thickness, and are drawn every 6 decameters (dam) from a base of 558 dam.


SAMPLE THICKNESS CHART
ISOBAR
THICKNESS LINE
C190-3893
14a

Uses of the thickness chart

- Mean temperature advection in the 1000-500-mb layer
  - Because of the thermal wind relationship, the mean temperature advection in the 1000-500-mb layer can be estimated by “advecting'' the 1000-500-mb thickness lines with the surface geostrophic wind (estimated from the surface isobars using Buys-Ballots Law).
    - Warm-air advection occurs in regions where the wind blows higher thickness values into a region presently occupied by lower values.


WARM AIR ADVECTION
510
516
528
534
540
546
552
558
564
570
576
582
588
594
600
606
612
618
624
630
636
642
648
654
660
666
672
678
684
690
696
702
708
714
720
726
732
738
744
750
756
762

Uses of the thickness chart

- Cold-air advection occurs in regions where the wind blows lower thickness values into a region presently occupied by higher values.
- Neutral temperature advection can occur in a number of ways

  – The wind is calm.
  – No thickness gradient exists.
  – The wind blows parallel to the thickness lines.

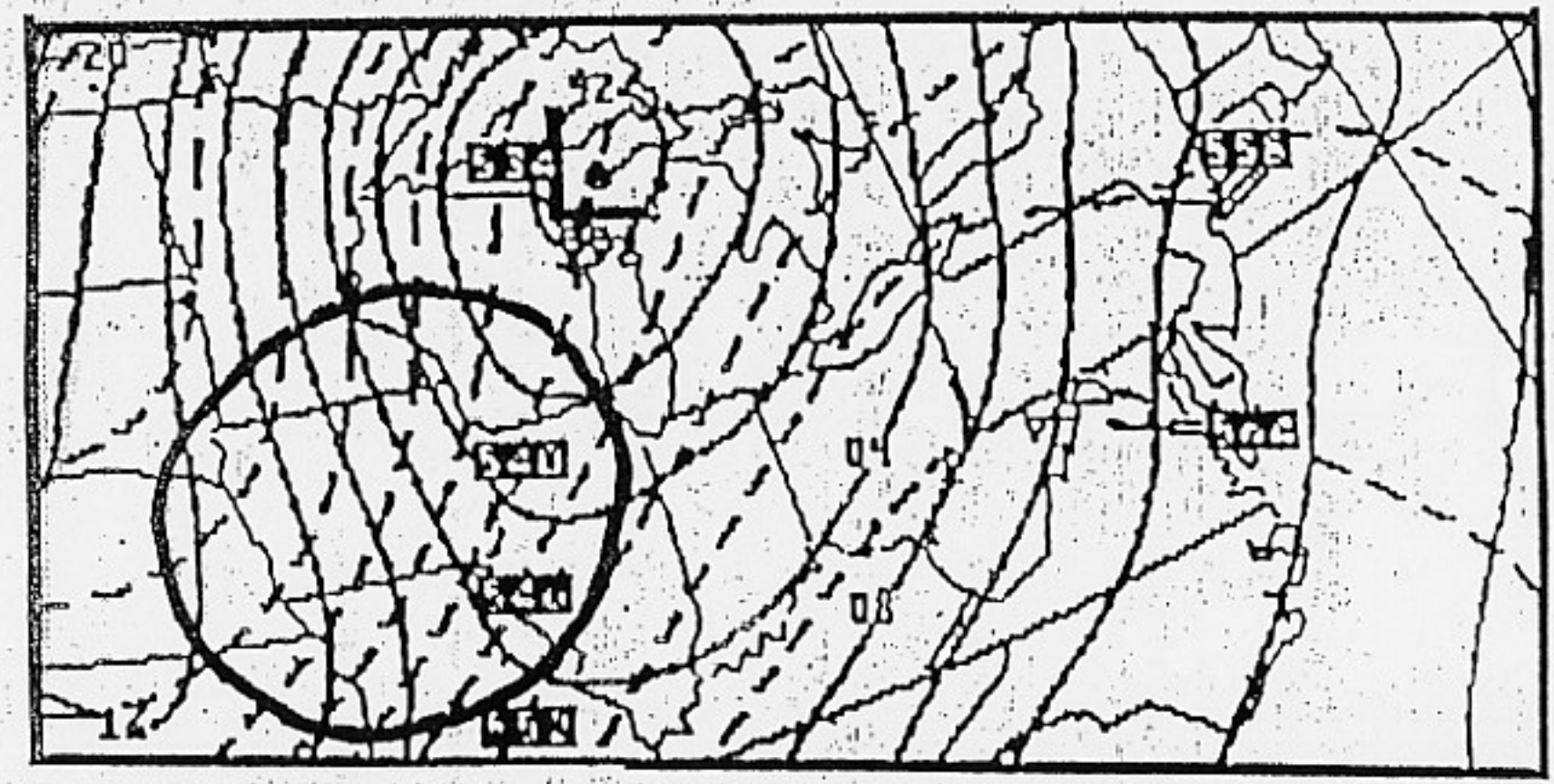
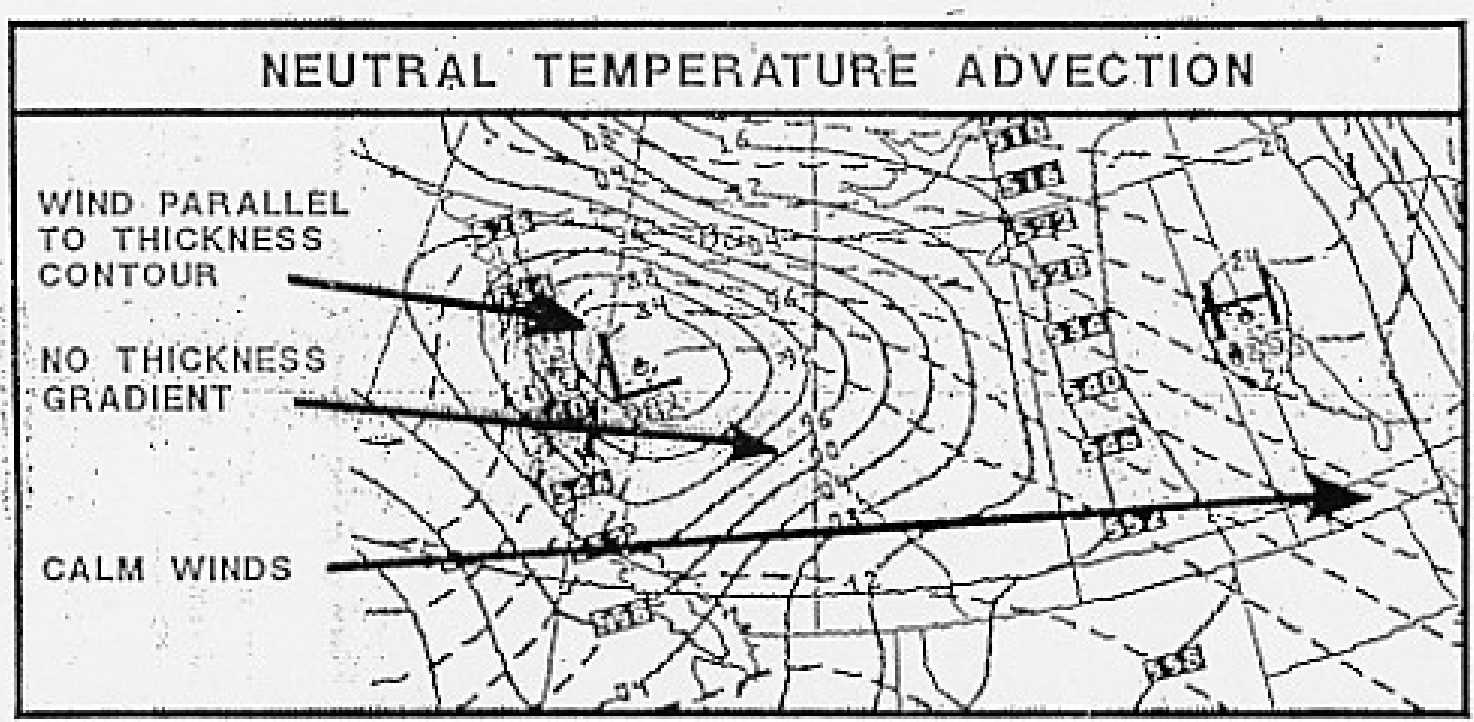
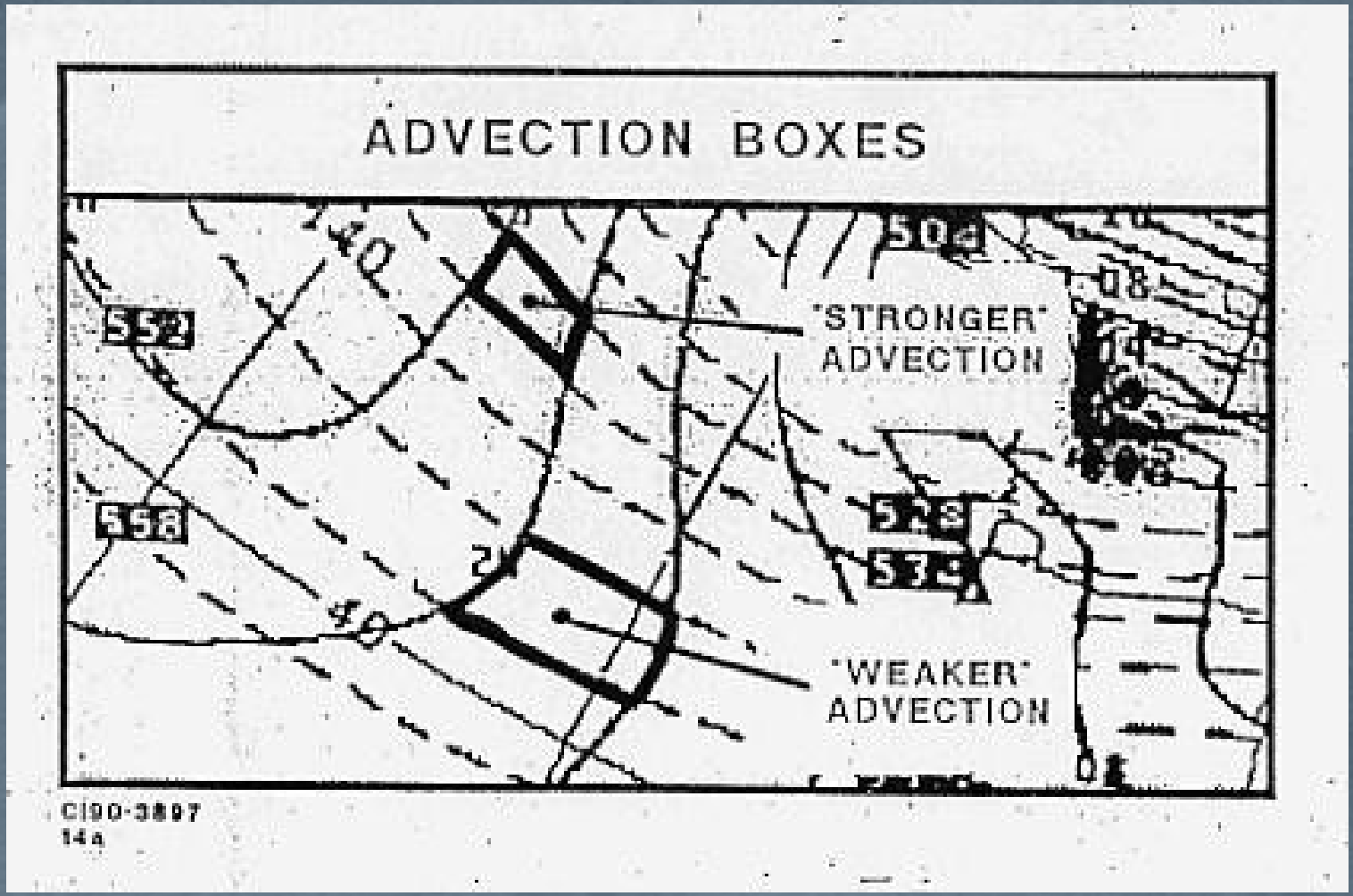


Figure 3-3: *Cold Air Advection*


NEUTRAL TEMPERATURE ADVECTION
WIND PARALLEL TO THICKNESS CONTOUR
NO THICKNESS GRADIENT
CALM WINDS
CI90-3898-14a

Uses of the thickness chart

- Mean temperature advection in the 1000-500 mb layer
  - The strength of the advection is inversely proportional to the area of the “advection boxes” on the chart.
    - An "advection box" is the box created by the intersection of two successive surface isobars and two successive thickness contours.
    - The smaller the "advection box" the stronger the advection.

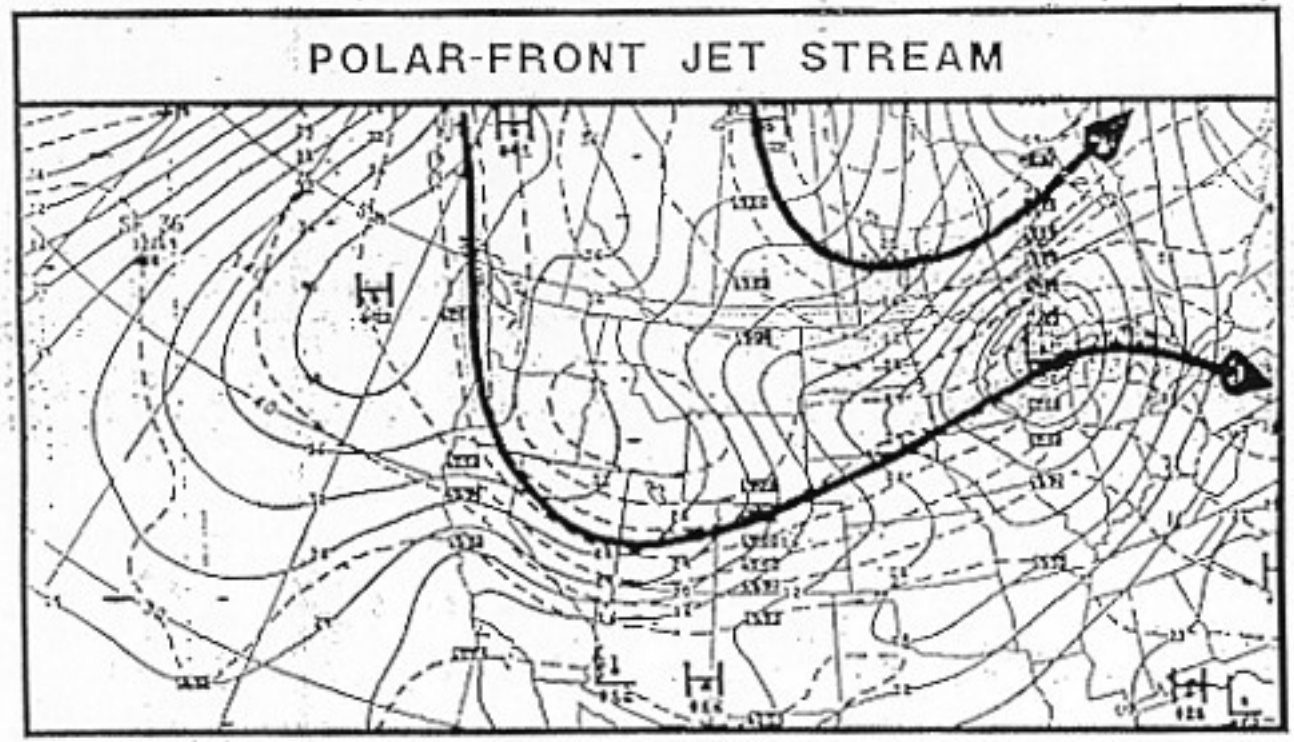

ADVECTION BOXES
"STRONGER" ADVECTION
"WEAKER" ADVECTION
C190-3897
14A

Uses of the thickness chart

- Rain/snow line during the cold season
  - In regions where the thickness is greater than 540 dam, precipitation is generally liquid.
  - In regions where the thickness is lower than 540 dam, precipitation is generally frozen.
  - The 540 dam thickness line is important because it is a good first guess at the rain/snow line.

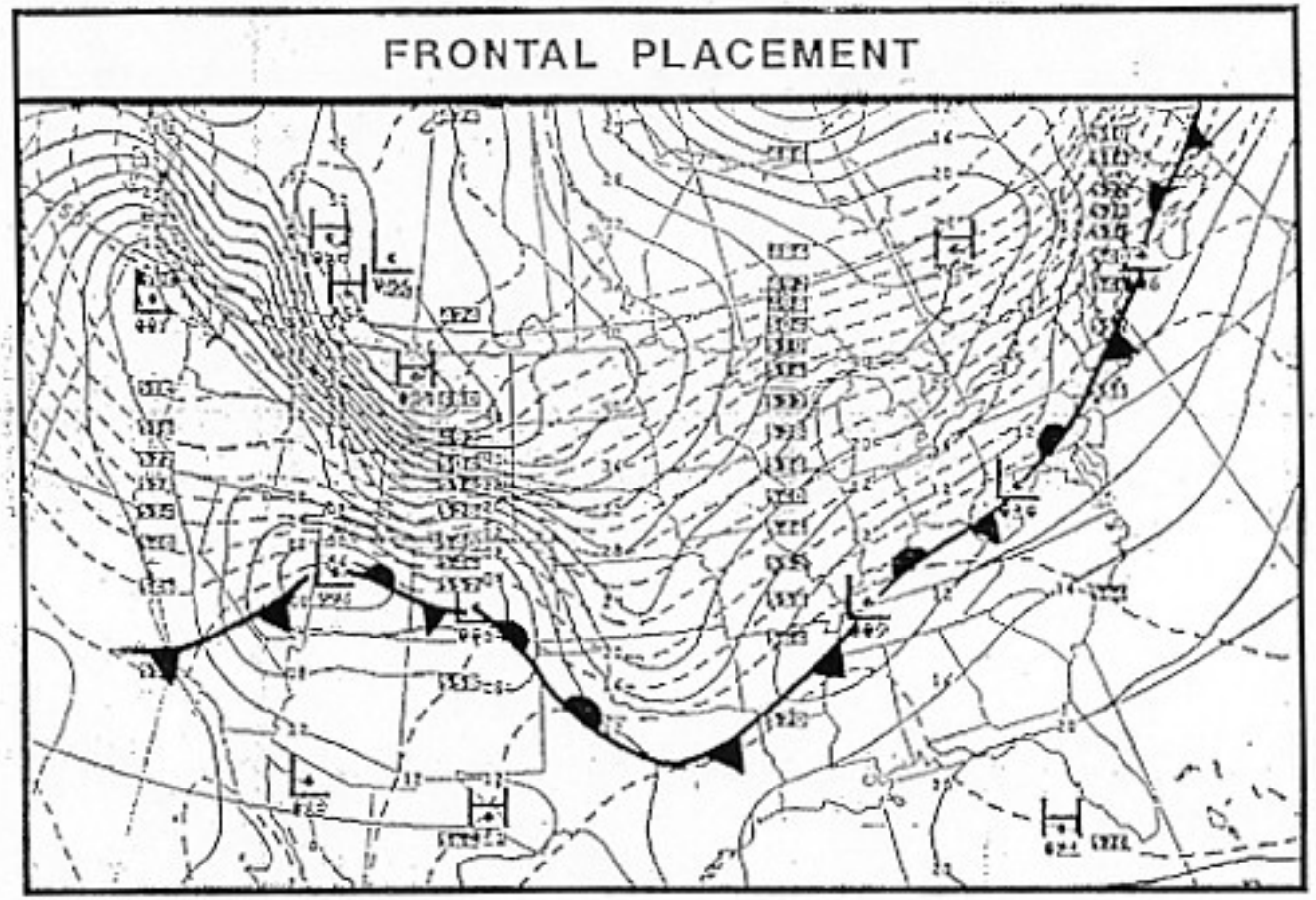
Uses of the thickness chart

- Polar-front jet stream
  - The polar-front jet is caused by horizontal temperature contrasts throughout the atmosphere.
  - These temperature contrasts appear as a region of closely spaced thickness lines called "thickness packing".
  - The thermal wind relationship shows that regions of strong thermal gradient cause strong winds at upper levels.
  - The polar-front jet is located over the tightest thickness packing


POLAR-FRONT JET STREAM
C190-3898
14a

Uses of the thickness chart

- Surface fronts
  - A front is the boundary between two air masses.
  - The transition zone between air masses is represented by thickness packing.


FRONTAL PLACEMENT
CI90-3899
14a

Uses of the thickness chart

- The surface front always lies on the warm side of the thickness packing.
  - If warm-air advection is occurring in the thickness packing associated with the front, the front is a warm front.
  - If cold-air advection is occurring in the thickness packing associated with the front, the front is a cold front.
  - If neutral temperature advection is occurring in the thickness packing associated with the front, the front is a stationary front.

Uses of the thickness chart

- Surface fronts are located in surface pressure troughs.
- Both the thickness packing and surface pressure pattern must be evaluated when estimating frontal position.
- Occlusions are located in/near the thermal ridge and pressure trough associated with a low pressure system. The occluded low must be embedded within, or on the cold side of the thickness gradient. This will be discussed in detail in Dynamics.

Thickness chart preparation

- Analyze areas of temperature advection.
  - Outline and shade regions of **SIGNIFICANT** warm air advection red.
  - Outline and shade regions of **SIGNIFICANT** cold air advection blue.
- Highlight the 540 dam thickness line with a green marker.
- Estimate the position of the polar-front jet and draw it on the chart in black.

Thickness chart preparation

- Locate surface fronts and draw them on the chart using standard conventions (blue for cold fronts and red for warm fronts).
  - This is just a first guess at frontal position.
  - Frontal analysis will be discussed in detail in Dynamics and Advanced Analysis.

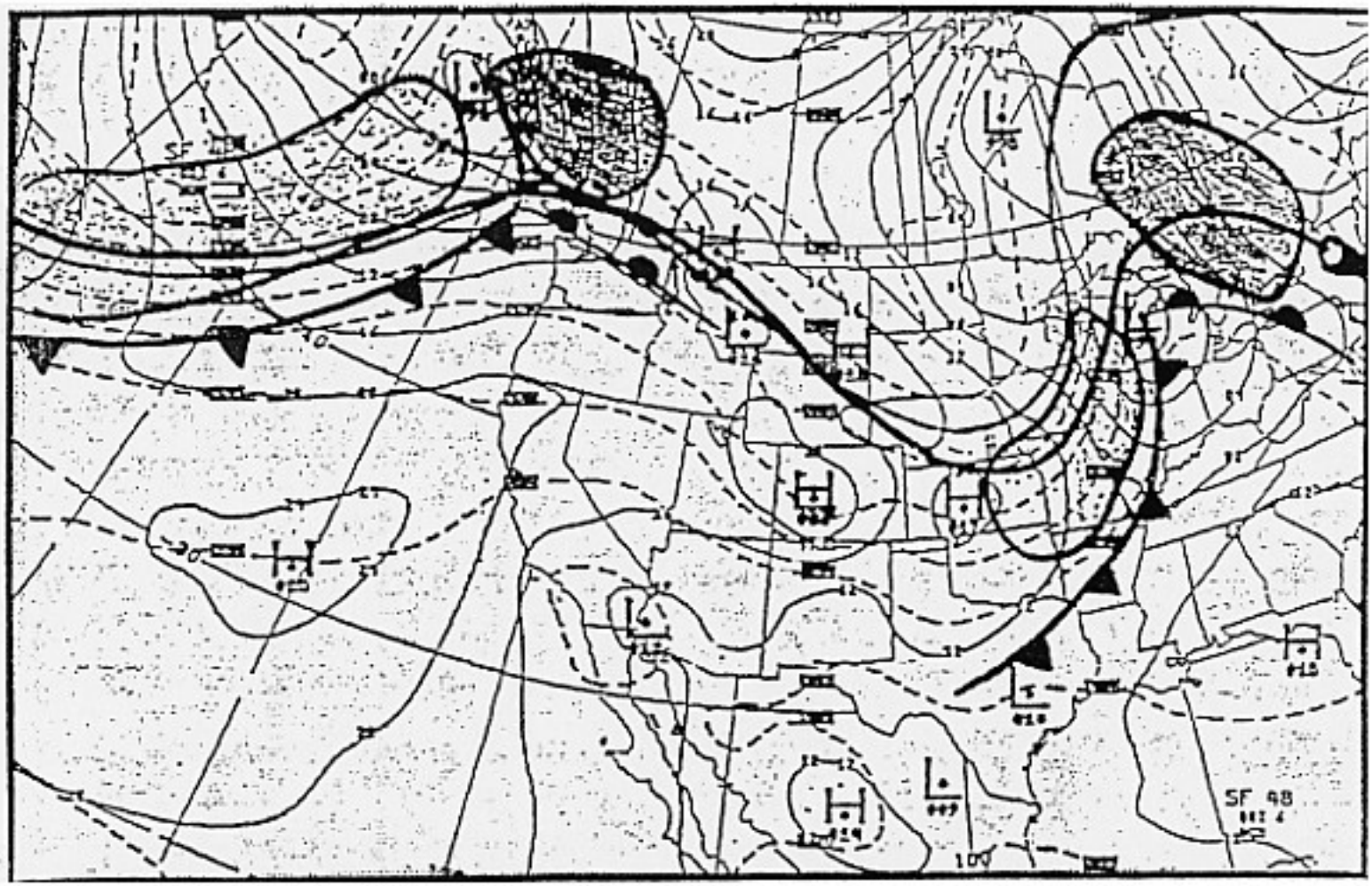


Figure 3-8. Sample of a Properly Prepared SFC/1000-500Mb Thickness Chart

- APPLICATION: Mar 1993 Chart Series
- EVALUATION: Administer and evaluate PC-104c. Give the written test at the end of the unit.